expected. The subject, however, is treated very concisely and generally very clearly. There is rather a want of lucidity, however, in his treatment of the synthesis of indigo on p. 512. The chapter on the diazo-compounds and the short *résumé* of Hantzsch's work in this direction are very good, and his remarks upon the electro-reduction of nitro compounds are also excellent.

Prof. Holleman pays particular attention to the physico-chemical side of the subject, an aspect which has been neglected by most writers of books on organic chemistry. On p. 188, for example, in the chapter upon polybasic acids, he devotes a long paragraph to their physical and chemical properties; again, on p. 196, he gives a clear explanation of the electro-synthesis of dibasic and other acids, while on p. 334 he describes Tafel's fine work on the electro-reduction of purine derivatives. In fact, one of the chief values of the work is the welding together of physical and organic chemistry.

The book is hardly suitable for beginners or for students who *want* (we will not say require) just a smattering of organic chemistry, but for the earnest student of the subject the work is one which can be most highly recommended. The style is good, the method of arrangement is excellent, and we think that there are few who will lay down the book after having studied it and feel disappointed.

Messrs. Wiley have produced the book in excellent style, and have spaced out the formulæ and equations in a lavish manner. Truly science knows no nationality—the book is written by a Hollander, translated by a Scotchman, and published by an American house.

F. M. P.

Education in Accordance with Natural Law. Suggestions for the Consideration of Parents, Teachers, and Social Reformers. By Charles B. Ingham. Pp. xi+125. (London: Novello and Co., Ltd.; New York: Novello, Ewer and Co., n.d.) Price 3*s.* net.

EVER since the publication of Rousseau's "Emile," with its well-known opening sentence, "Tout est bien sortant des mains de l'Auteur des choses, tout dégénère entre les mains de l'homme," there have been writers reflecting more or less satisfactorily the illuminating ray which Jean Jacques directed against the educational formalism of his day. Of course, if educational methods contravene the laws of nature, good results cannot be expected; but it is of supreme importance that writers venturing to define and formulate a system of education in conformity with natural law should at least first make sure that they understand the broad generalisations they call to their aid. An examination of Mr. Ingham's arguments gives rise to the suspicion that he has not completely mastered the conclusions at which men of science have arrived, and that his acquaintance with physical science is scarcely intimate. But Mr. Ingham is an experienced teacher, and has many sensible pieces of advice to offer, and even if the truths he advances are not new, they certainly are not universally adopted yet. To mention a few points on which the author has sound views is alone possible here. He advocates earnestly the need for more scientific methods in education; he pleads for more leisure time for boys and girls, in which they may follow their own devices; and he inveighs against the unsatisfactory early training of girls. He has not, we think, given science a sufficiently important place in the education of young people, but there can be little doubt that if parents could be persuaded to read the book they would have a clearer idea of what the aim of education should be.

A. T. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Psychophysical Interaction.

I AM interested by the letter of the professor of philosophy in the University of Birmingham on p. 126, and if your readers are not weary of the discussion—as I see no reason why they should be, since it is clearly a difficult question which must be discussed from time to time as science advances—I should like to add a few words.

When Prof. Muirhead says that my recent contention was advocated by Descartes, he is stating what is of interest, but what I did not know; I was not aware that the idea of energy, or even of momentum, was sufficiently clear in his era. But however this may be, he must not think that I regard the statement "that mind cannot produce energy" as axiomatic. It is a question not of axiom, but of fact. It seems to me that live things *do not* generate energy and *do* direct it; so I assert this, not as a necessity of thought, nor as an idea for which I have a special predilection, but simply as an experience. If Descartes maintained the same thesis, so much the more likely is it to be true.

Inert matter—all matter is inert—matter devoid of life then let us say, moves (technically, is accelerated) when and because it is pushed from behind. Live matter moves or is impelled to move from other motives; it is urged by anticipation of the future sometimes, by gratification of appetite for instance, or by avoidance of pain, often. A typical case is a costermonger's vehicle propelled by a bunch of carrots, or by the blows of a stick applied in indiscriminate profusion. There is nothing like that in storm or cataract or tide; nor is there anything like it in motor-car or railway-train, unless we include in the machinery the mind of the engineer.

Prof. Muirhead recommends a pacification of the question in the ultimate *nirvana* of idealistic monism. I am disposed to acquiesce ultimately in this destination, but I feel that there is something more proximate to be attained first. Philosophers go so fast and so far, they do not give the scientific man a chance; he wants to study the landscape and grub by the roadside. The ultimate outlook is doubtless there, very fine and attractive, like the setting sun; but the traveller to the west has much to see and much to do, and a constant gaze too far ahead may only dazzle him and unfit him for his proper work on the terrestrial sphere.

OLIVER LODGE.

Oxford, June 12.

THE opponents are not getting into close quarters. Dr. Hobson was irreproachable, but the others are using the word "force" all through the discussion, although it is the most unhappy word anyone could use in a controversy about fundamental physical conceptions. Its object is to enable us to contemplate one aspect of an action while we dismiss the other absolutely from our minds, because, when we want to give all our attention to one of the two bodies concerned, it helps us to ignore the other as much as possible.

It is remarkable also that Prof. Minchin should write that "guiding or deviating forces," if they allow the universe to keep its total energy intact, "infallibly alter its total momentum." Prof. Ward seems to have said the same thing, and the curious error remains without specific contradiction. Yet anyone who remembers that if there are n particles in the universe, there are $3n$ velocities for a sprite to amuse himself by tinkering with, will agree that he must, indeed, be a stupid or self-willed sprite who could not arrange to keep Σmv^2, $\Sigma m\dot{x}$, $\Sigma m\dot{y}$, and $\Sigma m\dot{z}$ unchanged while he disported himself with variations of the other $3n-4$ integrals.

Though that is merely a mistake on a side issue, an example on it will serve to put clearly the two different points of view. Suppose that there are two bodies of equal mass $2m$ moving due north with velocities of 9 and 1

units respectively, and without mutual action. The total energy is $m(9^2+1^2)=82m$, the total momentum due north is $2m(9+1)$, that due east is zero. At 12 o'clock the sprite wills that the first body should diminish its velocity due north to 5 and get one of 4 due east, while at the same time the second shall increase its velocity to 5 due north and get one of 4 due west. The bodies obey the sprite, of course, and even though he has by no means confined himself to "guiding or controlling forces," the energy remains the same, for $m(5^2+4^2+5^2+4^2)=82m$, and the total momentum north is $2m(5+5)$, and that east is $2m(4-4)$, *i.e.* $20m$ and 0, the same as before.

Now suppose a materialistic philosopher had been observing all this. Before 12 o'clock his observations of the continued uniform motion of the bodies would have led him to conclude that there was no mutual action between them, *i.e.* the law of the force was that it was zero. At 12 o'clock he would observe a change, and if ignorant that there was a sprite, would conclude that some other system, unseen by him, had come into collision with his system. If he is assured this is not the case, he will be driven to the only alternative, viz. that at 12 o'clock the *law of the action between them* had suddenly changed. (For the philosopher to say that a *force* had acted on the balls at 12 o'clock would be merely another way of saying that their motion had changed, because the definition of force, derived from Newton's laws, is "that which changes the state of motion of a body." Hence, whether he thought the action was due to a sprite, to an external material system, or to a change in the law of action between the bodies, the statement that at 12 o'clock a force had acted on each would be equally appropriate, and whatever supposition be adopted, the force would have the direction and magnitude, viz. that deduced by Newton's laws from the observed changes in the motion.)

Replace the two particles by the entire universe, and the point in dispute is really this. The physicist says, the changes in the motion of each particle at any instant depend solely on the positions of it and all the other particles, *according to laws which do not change with the time*. The form of the dependence, too, shows that there is but one future course of the motion—$\kappa.\lambda.\pi.\nu.$'s singular solutions do not come in—and that it only needs infinite mathematical knowledge to calculate, from the positions and velocities at 12 o'clock to-day, and the unalterable laws of mutual action, what every particle of the system will be doing at, say, 3 o'clock three hundred years hence.

It is open to anyone to deny this position, but he ought, I think, to state exactly how far he does deny it, even though he may not be able to state exactly what he wishes to substitute for it. What it seems to me necessary for Sir Oliver Lodge to deny is that these laws apply to living matter. He must say that if the motions of the material particles of which protoplasm is composed be examined (in conjunction, of course, with those of the rest of the universe), our materialistic philosopher would be compelled to conclude that a change in the law of action had taken place—just as he would in the case of the two particles, if he were certified that they composed the whole universe. The materialist philosopher would then, I imagine, be prepared to receive with attention, at all events, Sir Oliver's assurance that these extraordinary changes were due to an exertion of will- or psychic-power on the part of the protoplasm, and that the law of mutual action between the material particles was not changed at all—it was only "supplemented," I suppose he would say, by the action of mind on matter.

Whether this is really so or not is perhaps open to that reasonable doubt which may exist on any matter which has not been made the subject of conclusive experiment, and any man is entitled to say that he doubts whether an observation of the motions of live matter would not reveal something incompatible with the supposition that the "forces" acting on the particles of the universe are determined according to any fixed law, *i.e.* a law independent of the time.

It would be interesting, but inappropriate, to discuss how far such a supposition will help people in regard to "the efficacy of prayer and many another practical outcome of religious belief," the reality of which Sir Oliver and many others consider to depend on the attitude taken in regard to it. Practically the effect of a general adoption of the supposition would be that for many years to come it would be thought to have removed the difficulties, but after a time these would crop up exactly as before. When men became more familiar with the conception of spirit, they would ask of it also, *what laws it followed*, and in the mental, as in the physical world, the conception of a necessary law of operation would assert its absolute sway among the higher minds who make knowledge their object. For it is only that which is subject to law which can be the object of knowledge. That which is capricious can only be the subject of memory and conjecture. It is not in this direction that any permanent solution of difficulties is to be sought.

EDWARD P. CULVERWELL.

Trinity College, Dublin, May 28.

IN relation to the letters on "Psychophysical Interaction" appearing in NATURE, the initial questioning the discussion works back to is whether we are to recognise in mind the mere knower, or manipulator, as well, of animal action. In relation to such a questioning it may be of use to consider that what is inferred concerning mind as existing anywhere outside oneself is inferred by study of action displays. We possess no faculty which can directly become aware of the psychical outside oneself. It is in action we see it, if at all. The study of animal intelligence infers as to animal intelligence by seeing it in animal action. We meet with peculiar kinds of actions which seem to require intelligence for their origin; and therefore surmise as to animal intelligence. The observation holds of the human intelligences with which we come in contact. We can only get to know the mind of a man through his action that he acts intelligently; therefore he must be intelligent. A man may speak his ideas to us, and by his speaking convince us of his inlying intelligence; but in ultimate analysis talking is as much a muscular performance as walking. Or he may write his thoughts, and we by reading may see in what he has written that he has ideas; but if the mind is mere knower it cannot manipulate action to the writing down of ideas, and therefore this is effected in some other way. For all we may know to the contrary, the man vacant of mind may be more at large than we are apt to suspect, for by the mechanical hypothesis a man may talk rationally and yet not have ideas.

The mechanical hypothesis disposes of the actions of animals by the theory of their being fitted and adapted in reciprocal relation to environment by process of natural selection. Variations in action take place in species, and the species which are favoured with favourable variations in action in the long run survive. The theory explains many of the adjustments of animal action, but not all. There are instances to which the hypothesis can never extend, and they are the instances of action which are put in in circumstances where there is no scope for natural selection to work. Take, for instance, a man learning to play a cornet. The learning to play a cornet is the putting in of an action process, and as such is worthy of biologic consideration. The man learns to play the instrument by manipulating his breathing and fingering the keys. He studies the music before him, and internally, and mentally, decides upon the fingering which is appropriate. His breathing into the instrument is timed by his mental translation of signs given by the printed page. Each stage of his practising is revised by hearing. Where he plays a false note he goes back, and exercises extra attention to do better.

The entire action of players in a cricket field is action adjusted in relation to the motion of the ball. It is action determined by seeing. Deduct the seeing and it cannot be done. And cricket has not been long enough in existence for natural selection to have anything to do with it. So the editing of NATURE is an intelligent-mechanical process. Deduct the intelligence in that process, and it cannot be done. The expert conjurer, equilibrist, or trick cyclist depends upon the alertness of his sensations for the correctness of his performance.

Apparently in the whole proceeding of animal action, excepting the old established automatic, knowing, seeing, hearing, feeling, plays its part. Ants will eat sugar but not saccharin. The *taste* to them is not as sugar. So